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ABSTRACT

A Title III project was initiated to develop and test a program of computer-assisted instruction (CAI) in mathematics and reading for approximately 400 visually or aurally handicapped students in Cincinnati. Students were identified and given pretests to determine their needs, and their special education teachers were trained to prepare appropriate CAI lesson material and to monitor student progress. During the project's initial year, the achievement of deaf students was analyzed, and attitude scales were administered to teachers, students, and parents. Preliminary results indicated that teachers were able to implement the CAI system with deaf students; that CAI was beneficial for the hearing-impaired; that students, teachers, and parents reacted favorably toward CAI use; and that further hardware and software development will be necessary before CAI can be fully implemented and tested with visually impaired students. (LH)

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COMPUTER-ASSISTED INSTRUCTION FOR THE BLIND AND DEAF

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Introduction

This paper describes the initial efforts and results of an ESEA Title III funded project to develop and test a computer-assisted instructional system for hearing and vision handicapped students. The purpose of the project is to design and test a feasible system for providing computer-based drill and practice lessons in a form best suited to the special needs of children with vision or hearing impairments.

This project was initiated as a result of the need to provide a regular system of drill and practice instructional support in basic skills to special education teachers of the hearing and vision impaired. With the many special instructional needs these children have, a method was sought which could provide ongoing drill and practice in reading and arithmetic fundamentals to certain students in the classroom while the teacher worked with others. Because of the small number of students in special education classes, use of computer-assisted instruction (CAI) would allow a few students at a time to work independently in reading or arithmetic in a self-paced manner while the teacher grouped the other children for instruction in other areas.

While computer-assisted instruction has been well-developed and used successfully with regular children, there have not been many efforts to adapt it to the special needs of handicapped students. Thus, it was found that there was also a need to develop hardware and software adapted to the

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special needs of the hearing and vision impaired.

Finally, it was necessary to train special education teachers in the use of CAI as a supplement to their regular instructional program. While most of the available CAI lessons in reading and math are appropriate for special students, a need was seen to have the teachers prepare lessons especially suited to the special instructional needs of their students.

The following project objectives were developed from the needs identified above:

1. To assess the effect of regular drill and practice CAI lessons on the reading and arithmetic achievement of hearing and vision impaired students
2. To design, test, and implement hardware and software adapted to the special needs of blind and deaf students
3. To train teachers of blind and deaf students in the use of computer-assisted instruction and in the preparation of lesson material written by teachers for use on the computer by students.

Review of Literature

A major review of research on cognition in handicapped children was recently published by Suppes (1974) in the Review of Educational Research. Suppes characterized blind children as "information-poor" since they do not have an alternative input channel which can match the rate of visual processing. Thus they are frequently retarded in both language skills and concept formation. Bick (1966) found that visually-handicapped children were academically retarded by about $2\frac{1}{2}$ years in achievement. Brothers (1972) reported that braille students tested in 1970 scored approximately 27% below the sighted norm in math achievement.

Suppes identified "competence in a standard natural language as the outstanding defect and problem of deaf persons (1974, p. 152.)" In arithmetic, Suppes reported that deaf children usually show an achievement deficit in relation to their age, and their rate of progress is usually below that of normal children. Suppes also reported the results of his studies using CAI with deaf children and found that deaf children performed as well as, and in some cases better than, normal students in arithmetic skills. He attributed this to the lower verbal component in mathematics.

Procedures

Under an ESEA Title III grant, funding was made available to the Department of Research and Development of the Cincinnati Public Schools to develop and test a computer-assisted instructional system for blind and deaf children. The Department had previously tested and successfully implemented a number of computer-assisted instructional programs in reading and mathematics as part of the regular school program. In this project, an effort was made to adapt the regular CAI system to the special needs of visually and hearing impaired children.

The number of visual and hearing impaired students being served through Special Education in the Cincinnati Public Schools was identified. For the visually handicapped, these included children who could read regular print with special corrective lenses, those who could read only enlarged print, and Braille readers. These children, 30 in number from throughout the school district, attend a special Vision Center at one elementary school.

The hearing impaired students were those with an eighty percent or greater hearing loss in both ears. These included both lip readers and users of sign language. There were a total of 350 hearing-impaired students

in grades one through twelve identified as eligible for the project. One hundred eighty of these children attended a residential parochial school for the deaf, while the others (170) were in four schools of the public school system.

The CAI drill and practice programs in reading and mathematics used in the Cincinnati schools employ a strand approach. Sequences of related items in reading and math areas are clustered into strands such as vocabulary and literal comprehension or subtraction and fractions. Individual lessons are prepared by the computer based on the child's present level of achievement. Student performance then provides feedback to select subsequent items. Branching within and between strands is built into the programs. The material a student receives from a strand is independent of his or her position in other strands.

The subject matter in the strands covers the standard curriculum in grades one through twelve and has been validated through content analysis of standard textbooks and achievement tests. Each day, progress reports are generated for teachers to give feedback necessary to individualize instruction and remediate weaknesses. Weekly and monthly progress reports are also generated by the computer for the student as well as the teacher.

Presentation of the CAI lessons to the deaf children was a relatively standard operation. Lessons are presented on a teletype machine connected to a central computer. After receiving instruction on use of the standard typewriter keyboard, students can enter and use the CAI system on their own. Students are scheduled for ten minute sessions a day on the computer.

For the blind students, much more work has gone into development of feasible methods of providing CAI lessons. The partial-sighted students have

had difficulty reading typewriter-size print on the teletype. An effort is being made to investigate methods of presenting lessons in large type through a video attachment or magnifying lens.

Developing a conversion system for translating natural language into Grade II Braille and the Nemeth Code in mathematics is an important part of the project. Development of this system will allow the Braille user to read the items in Braille, type in his response in natural language, and receive feedback in Braille. Testing of various Braille printers with the other CAI hardware is also taking place during the project.

In addition to these efforts directed specifically at students, teachers in the project are being trained in the preparation of lesson material written especially for the needs of their deaf and blind students. These lessons will be written in CAI format so that they can be entered directly into the computer system and tested on the students.

Results

The visually-impaired students have participated in the project on a very limited basis to this point. Most of the efforts for these students have been directed to testing and modifying equipment to suit their needs and developing a conversion system for translating natural language into Grade II Braille and the Nemeth Code. Currently, work is underway to adapt a Braille printer to the CAI terminals for use by the Braille reading students.

Program needs of the partial-sighted are also challenging. No one optic system will magnify the teletype print sufficiently for all students. Efforts to adapt a large-print advertising-type printer to the CAI terminals were also not successful. Consequently, partial-sighted children are unable

to participate in the project.

Nevertheless, all partial-sighted and Braille-reading students who were scheduled to participate in the project were pretested in arithmetic in September, 1974. The Key Math Diagnostic Arithmetic Test was adapted for use with these students. Results showed that for 17 children tested, they were from six months to three years behind their grade placement in arithmetic achievement. The visually-impaired students did best on subtests involving numerical operations and had the most difficulty on tests involving numerical reasoning and applications to time, measurement, and money problems.

During the initial year of the project, achievement of deaf students in the project was analyzed in terms of gains per month of CAI usage. Table 1 gives these results for four schools in reading and five schools in math.

Table 1. Achievement Gains Per Month of CAI Usage.

School	N	Mean # of Months of Reading Achievement Gains per Student	Mean # of Months of CAI Usage	Reading Gains Per Month of Usage
St. Rita	42	5.80	4.09	1.39
Merry	9	2.10	2.45	0.86
Withrow	23	1.83	1.60	1.14
Woodward	10	-0.50	2.90	-0.17

School	N	Mean # of Months of Math Achievement Gains per Student	Mean # of Months of CAI Usage	Math Gains Per Month of Usage
Clifton	12	8.50	3.39	2.51
St. Rita	93	3.74	2.54	1.47
Merry	16	4.75	2.17	2.18
Withrow	22	2.32	0.84	2.77
Woodward	11	10.3	1.69	6.10

Note: Pretest administered in September 1973, post-test in May 1974.

Of the nine groups for whom achievement test results were available, on the California Achievement Test, four in reading and five in math, seven met the stated criterion level of one month increase in reading or math skills for each month of CAI usage. The students at Merry almost met the criterion in reading while the group at Woodward actually experienced a decrease in tested achievement in reading.

On the whole, the gains are more impressive in math where three of the five groups gained over two months of achievement per month of CAI usage. This finding coincides with the general finding that deaf students perform better in math than reading because of the lesser language component in mathematics.

It should be noted that the data reported for Woodward in reading and math are highly suspect since large decreases in tested achievement for some students accounted for the negative results in reading, and unusually large increases in tested math achievement produced the unlikely results there. It appears that the test results in both subjects are questionable for the Woodward students.

Pretest results for the 1974-75 school year are reported in Table 2.

Table 2. Pretest Results for Hearing-Impaired Students, 1974-75.

READING

School	Level	N	Vocabulary	Comprehension	Total
Clifton Elementary	2	6	1.6	2.2	1.7
Merry Jr. High	1	9	1.1	1.3	1.1
	2	13	2.4	2.9	2.7
	3	2	3.3	5.9	4.6
Withrow Sr. High	2	4	3.0	4.0	3.5
	3	11	4.8	5.4	5.1
	4	3	5.1	7.7	6.1
	5	4	7.8	8.5	8.3
Woodward Sr. High	1	6	1.0	1.6	1.2
	2	13	1.9	2.5	2.2
	3	3	3.8	5.1	4.4

MATHEMATICS

School	Level	N	Computation	Concepts & Problems	Total
Clifton Elementary	1	21	1.2	0.8	1.0
	2	12	1.2	0.6	0.9
	3	2	4.6	4.9	4.6
Merry Jr. High	1	8	2.2	1.5	1.8
	2	14	3.7	2.9	3.4
	3	2	5.9	5.7	5.8
Withrow Sr. High	2	2	4.5	4.5	4.5
	3	9	5.4	4.6	5.2
	4	6	9.2	6.9	8.1
	5	5	12.8	11.7	12.3
Woodward Sr. High	1	2	2.4	0.9	1.7
	2	11	2.8	1.7	2.4
	3	8	4.8	3.7	4.2
	4	1	8.1	4.9	6.8

Clifton Elementary has children in grades 1-6, Merry contains grades 7-9, and the two senior highs, grades 10-12. However, since grade levels are not as meaningful for handicapped children, the results are reported in terms of the average score for each level of the test administered.

Generally, the results confirm what we have found previously in this project and elsewhere - better achievement in mathematics than in reading for hearing-impaired children. In Reading, at each level of the test, the project students were higher, sometimes over one grade level higher, in Comprehension than in Vocabulary. This means that their language experience is somewhat limited but they understand well what they do read. In Mathematics, the project students generally did better in the Computation than the Concepts and Problems section of the tests. This indicates better skills in basic operations such as addition, etc., but also reflects the difficulty they encounter with the greater language (reading) component of the Concepts and Problems items on the Mathematics tests.

Results of the teacher-training component of the project indicate that teachers were well-prepared in the skills necessary to enroll and monitor student progress in the CAI programs. Thirteen of fifteen items on a skill-mastery test administered during a 40-hour preservice training period were answered correctly by 90% of the teachers, as called for in the project performance objective.

During the training period, teachers were also instructed in preparing and entering their own CAI lessons. By the end of the training, each teacher had successfully entered one lesson. They are to complete and enter three more lessons during the remainder of the school year.

Finally, attitude scales were administered to students, teachers, and parents of students involved in the project at the end of the first year.

Results obtained indicated favorable reactions toward CAI on the part of all three groups. In addition to the survey scale items, each group was asked to respond to some open-ended questions about the project.

Project students were asked to indicate what they liked and disliked about using the computer. The students felt that using the computer improved their learning generally and reading and math skills specifically. They liked the work presented and apparently enjoyed the novelty of typing their work. The students did not like it when the computer system was not working and also felt that they did not get enough time to answer. Some also felt the work was too hard for them and that wrong answers were not explained. The students' comments were generally favorable and their complaints only centered on the mechanical aspects of the system.

The project teachers were asked to indicate strengths and weaknesses of the project and give recommendations to modify and improve it. They felt that the additional drill and practice of the CAI system was beneficial and that it helped motivate the students. The difficulty of some of the material, and mechanical aspects such as poor readability of the print and "downtime" were considered weaknesses. The teachers were very strong in the recommendations that additional time and training be given to teachers to prepare their own CAI lessons. They also felt that the visual presentation of the lessons on the terminal should be improved.

Parents of the project students were also asked to comment on the project and give suggestions for changes next year. Their responses were very positive regarding the benefits they felt their children had derived and in being informed of their progress through the weekly reports. They expressed a desire to be kept better informed of the activities in the project.

Summary

Results available thus far indicate the computer-assisted instruction is definitely feasible and beneficial for hearing-impaired students. Further development, in terms of both hardware and software, is necessary before the effectiveness of CAI can be fully tested with visually-impaired students. Students, teachers, and parents have reacted favorably toward the use of CAI. Teachers have been able to implement and use the CAI system with deaf students quite easily.

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